WP1 TASK 1.2

Geopolitical scenarios and investor opportunities

ABSTRACT

Task 1.2 had three main research questions: (1) What types of national visions for hydrogen development exist in key countries of hydrogen geopolitics, and what types of national interests drive these visions? (2) To what extent can these national interests and visions be realized? (3) How will the emerging hydrogen geopolitics shape the choices of Finnish business actors? Regarding question (1), case studies were conducted on the national hydrogen visions in the USA, Australia, China, India, Japan and Russia, and the underpinning national interests. Regarding question (2), the structuration model of energy policy formation (e.g. Aalto et al. 2021) was adapted to the needs of hydrogen analysis, to study how various structural qualities enable and constrain visions and policies pursued. To answer question (3), more abstract country actor types were constructed: fossil fuel producers having to adapt to the demand for renewable and/or 'clean' hydrogen fuels (USA, Russia, Australia, Gulf Cooperation Council Member States); likely major exporters (Australia; possibly India); likely major importers (Japan, EU); and largely self-sufficient countries not expected to greatly shape global hydrogen fuel trade, but which could offer technologies (USA, China) (see Figure 1.2.1). The patterns of energy security and diplomacy were then analyzed for this actor constellation.

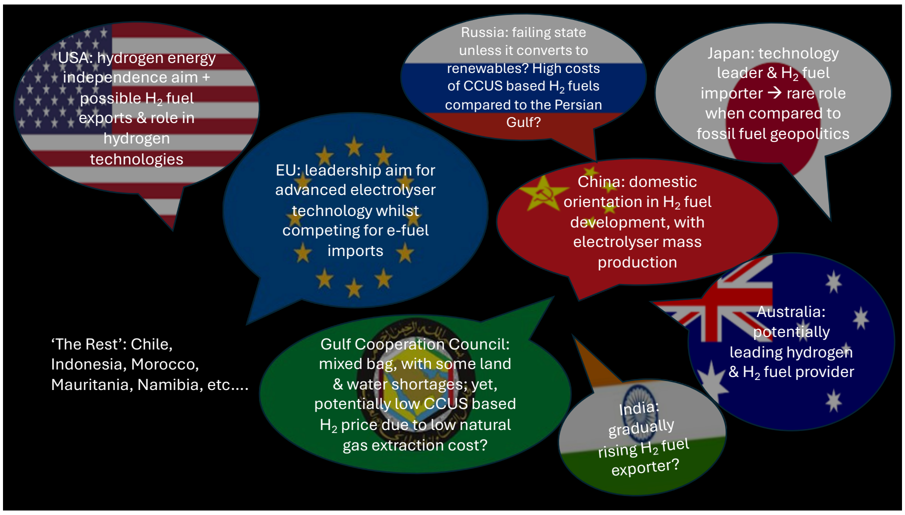

Figure 1.2.1 Some key actors in hydrogen geopolitics

MOTIVATION

Industrial development including hydrogen sectors increasingly takes place in a context wherein liberal trade and economy, and least-cost options including highly optimized supply chains are no longer the global rule. Instead, we find return to (green/clean) developmentalism, that is massive state aid in key countries, leading to state capitalism in some of them; along with friend-shoring and foreign investment screening, plus intensifying trade wars and competition among the USA, China, EU and Russia, as well the emergence of a wider BRICS, along with grey zone activities in NATO members states and military warfare in their neighbourhood. In this geopolitical setting, RDI and prospective trade in hydrogen value added sectors become infiltrated with political risks (i.e., regulatory risk) and geopolitical risks (targeting of vulnerabilities of states, and public and private companies including critical infrastructure owners, operators and users). Understanding the national interests of key countries, how these interests affect their industrial and commercial sectors, and the associated geopolitical risk is crucial for long-term RDI and infrastructure investments.

RESULTS

The results are disseminated via MBA type 5ECTS online course ‘Geopolitics of hydrogen’ offered via FiTech; briefs circulated via e.g. HYGCEL; all results are also compiled into a 65,000-80,000 collective monograph contracted with Palgrave, to be published in spring 2025.

The results indicate that:

- hydrogen fuel markets are likely to emerge first in a relatively fragmented form, given the different standards for renewable or ‘clean’ hydrogen adopted in key countries
- since transport costs are set to be higher than initially thought – as also suggested by other HYGCEL WPs – and access to High Seas may become limited due to terrorism, wars and threats by rogue states, the markets may remain quite regional
- key countries pursue largely similar, strong RDI support and demand creation policies (e.g. the EU, India, Japan, the USA) (for examples, see tables 1.2.1 – 1.2.2)

Command-and-control	Example	Notes
Performance standards	RFNBO (= renewable liquid and gaseous fuels of non-biological origin)	Criterion: 3.4kg of CO_2e/kg H_2 (volumetric); or 28.2g CO_2e/MJ (energy)
Targets		
EU gas and hydrogen package (2023/2024)	42.5% of H_2 renewable by 2030) = 4Mt; 60% 2035	Missing target for 2040; by 2050, hydrogen is to make up 13-20% of the EU energy mix (presumably 100% RFNBO)
ReFuelEU Aviation (Fit for 55 package)	1.2% of aviation fuel 'synthetic' RFNBO by 2030; rising to 35% by 2050	The 1.2% can include also CCUS based fuels fulfilling the RFNBO criteria
FuelEUMaritime (Fit for 55 package)	1% transport fuels renewable H_2 by 2030 (RFNBO) = 360.000t	Efforts to steer the 1% towards the aviation and maritime sectors
Blending obligation (Hydrogen and Gas package (2023/24)	Natural gas pipeline operators to accept 2% H_2 1.10.2025→ 75% tariff discount for low-carbon gas, 100% discount for renewable H_2	Initially, a 5% target proposed by the European Commission, watered down by Member States
Incentives		
Hydrogen Bank	720Me in subsidies in the first round (CfD type) for 1.58Mt production in 10 years, 7 projects (one of these to Finland); second round 1.2Me	Member States' own incentives for projects not receiving EU funding, e.g. DE 350M€; EST 39Me
RDI support	Clean Hydrogen Partnership: 190M€ (2024); ICPEI 6.9bln €; + Horixon Europe, RRF, etc.	Member States subsidise their own projects not qualifying for ICPEI, 10M€+ in BR, NET, DE, DK

Table 1.2.1 EU policy instruments for hydrogen development (examples)

Command-and-control	Examples	Notes
Performance standard	Green Hydrogen Standard for India (2023)	Criterion for RES based, incl. biomass; < 2.0 kgCO_2e/kg of H_2 (12months average); methodology TBA
Target	'Self-reliant India' scheme (2020)	Energy independence by 2047
Incentives		
Production subsidy	USD 25mln →5 Mt of 'renewable' hydrogen by 2030 (with 125GW RES capacity additions)	May reach 10 Mt/yr incl. exports
Competitive bidding scheme, 2.2bln USD	Subsidy for electrolyser development	Part of SIGHT programme
Competitive bidding scheme, 2.2bln USD	Subsidy for RES based H_2 production	Part of SIGHT; USD 0.64/kg) for 1st year, USD 0.51/k) for 2nd year; USD 0.38/Kg) for 3rd year
Waiver	Electricity transmission charge exemption	Until 2030/2036
Management instruments	Manufacturing zones for green H_2	Spatial planning policy
	H2 safety certification programme	
	H2 fuel quality control system	

Sources: e.g. IEA (2023); Pal et al. (2024); Government of India (2023)

Table 1.2.2 India's policy instruments for hydrogen development (examples)

- China appears to lead the mass development of electrolyser production, but mostly in less high-tech segments, whereas the RDI focus is on very substantial cost reductions of highly efficient electrolyzers in Japan (1/6 of current price);
- Japan has considerably revised its wide-reaching, pioneering 'Hydrogen society' strategy, after first intending hydrogen consumption in nearly all sectors, to focus on electrolyser technology; hydrogen applications in (heavy) transport; residential heating; and co-generation of ammonia with coal. However, some of these revised priorities appear ill-focused in global comparison. This can be explained by how Japan's energy sector has a long-term path-dependency on nuclear energy priority, and on (fossil) fuels use in heating and power generation. Because of these path-dependencies, Japan is opting for solutions out of sync with global energy transitions (coal-based ammonia), and for some highly inefficient solutions (imported gaseous H_2 fuels in heating vs. heat pumps). However, the Japanese industry's long-term competitive edge in efficiency improvements for its part is functional and path-creating for developing electrolysers and heavy transport applications (Figure 1.2.2);

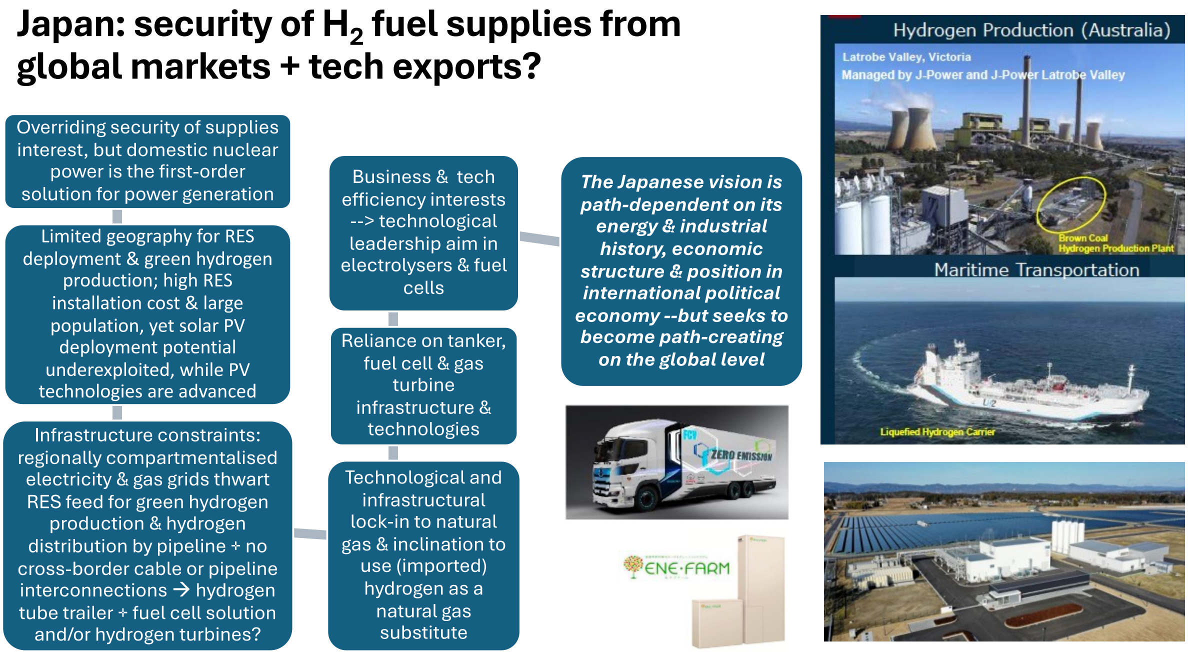

Figure 1.2.2 Some elements of Japan's hydrogen strategy

- out of major fossil fuel producers, Russia is unlikely to play much of a role in hydrogen value added sectors globally despite early phase projects e.g. with Norwegian and Japanese partners prior to 2022; however, Japan needs Russia as a geopolitical counterweight to China and North Korea, and may seek to store CO_2 in Russia's Sakhalin Island in the future;
- energy security in the hydrogen context will have a networked nature, requiring coordination between critical infrastructure owners and operators, private security actors and states, since no one actor is in full command of security practices such as technical resilience (critical infrastructure operators); risk management (e.g. insurance/owners), safety (companies for practice, authorities for requirements), local level resilience (municipalities), surveillance & intelligence (private and public); security governance (policing), and military protection of assets;

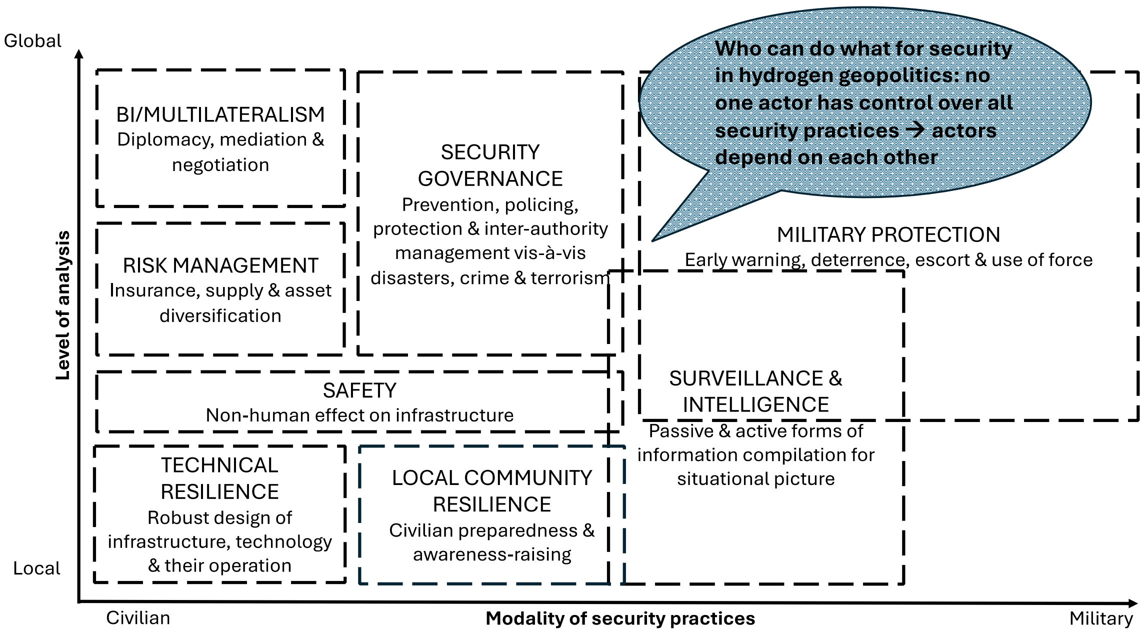

Figure 1.2.3 Security practices actors can use in hydrogen geopolitics

- regarding these security practices, the Finnish and EU focus so far in hydrogen infrastructure development leans heavily on technical resilience, safety and risk management practices. These will be insufficient on their own in the geopolitical conditions that have emerged since 2022. Notably, bilateralism or multilateralism cannot likely solve the problem due to the EU, Russia and NATO lacking diplomatic channels in the medium to long-term. Security governance for its part is as a rule functional when the damage has already been done, e.g. sabotage of infrastructure. Surveillance and intelligence can give early warning and act as deterrent against cyber threats (operation systems) and kinetic threats (rocket; missile; drone, etc.), whereas military protection is expensive and can ultimately be only partial. Planners of extensive, cross-national and/or undersea pipelines must take a notice of the vulnerabilities of such infrastructure and of required security practices.

- many H_2 fuel producer countries relying on maritime supplies via the High Seas, most prominently Persian Gulf exporters, will become vulnerable in case US-dependent military protection of the High Seas weakens (further), which may be an eventuality; EU & China will have a hard time replacing the USA in this function
- at the same time, most diplomatic activity to back up emerging hydrogen-based fuel trade is bilateral, whilst the capacity of major powers to agree on multilaterally may remain seriously compromised for several years, suggesting that global standards supporting the trade may develop slowly
- in this emerging setting, the main markets for Finnish actors will likely be in central Europe (e.g. Germany, Benelux) and in the UK, in the form of e-methanol/e-ammonia
- the EU markets would be widest for Finnish hydrogen-based fuels were the EU to adopt stricter strategic autonomy policies; however, several EU Member States are already developing hydrogen fuel trade with the EU's regional neighbours
- It is notable that state aid in Finland for 'hydrogen push' is not on the same level as that of some potent competitors, and this may delay Finland's start

APPLICATIONS/IMPACT

In the emerging geopolitical conditions – considering the security practices available for Finnish actors nationally and in the EU and NATO context – our conclusion regarding Finnish H_2 fuel exports is that a direct hydrogen pipeline from Finland to Germany or Estonia can be not only economically suboptimal as suggested by other HYGCEL work. It can also be difficult, or rather, impossible to secure in the current grey zone situation, let alone in a war situation for which Finland must also prepare. Hence not only higher value-added products such as e-ammonia but also alternative trade routes via Sweden and Norway should be actively pursued, including routing through Sweden, Norway and the Norwegian Sea, or Norway and the Barents Sea. Decentralized infrastructure options should also be considered as part of the domestic Finnish hydrogen production, delivery and utilization systems despite these lacking economies of scale benefits. Such systems may be especially relevant in areas with no local or nearby access to biomass. Prospectively, decentralized solutions may turn into business opportunities as resilient energy concepts, devices and services are needed also in many other countries than Finland.

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